DOWNGRADIENT SAMPLING REPORT

HENDERSON, NEVADA

Prepared by

Geosyntec consultants

engineers | scientists | innovators

2100 Main Street, Suite 150
Huntington Beach, CA 92648
Telephone: (714) 969-0800
Fax (714) 969-0820
www.geosyntec.com

Project Number: HW0934B

25 May 2007

EXECUTIVE SUMMARY

ES.1 OVERVIEW OF THE DOWNGRADIENT STUDY

This report for the Downgradient Study is being submitted on behalf of Montrose Chemical Corporation of California (Montrose), Pioneer Americas LLC (Pioneer), Stauffer Management Company LLC/Syngenta Crop Protection, Inc. (Stauffer/Syngenta) herein referred to as "the Companies."

This Downgradient Study consisted of a one-time sampling event of 22 existing monitor wells selected in the Downgradient Study Area and is described in the *Work Plan for the Downgradient Groundwater Sampling Event* (Geosyntec, 2006a). The Companies received approval to commence the Downgradient Study from the Nevada Department of Environmental Protection (NDEP) on March 15, 2006, contingent upon finalizing the respective site-related chemicals (SRCs) list for both the former Montrose and former Stauffer sites. NDEP approval for both of these SRC lists (herein referred to as the "combined SRC list") was received by July 17, 2006.

The monitor wells that were selected for the Downgradient Study were first field-verified in March 2006, then sampled in mid to late July and early August 2006, after obtaining NDEP approval of the combined SRC list. The sample results were received in late 2006, while all final data validation reports were not received until late February 2007.

This report presents the results from this sampling event and briefly discusses the findings. A more detailed evaluation of these findings will be incorporated into the ongoing development of the combined site-wide Conceptual Site Model (CSM), which is due to NDEP in the fall of 2007.

ES.2 OBJECTIVES OF THE DOWNGRADIENT STUDY

The first objective of the Downgradient Study was to collect one round of data for both groundwater-level elevations and groundwater quality in the downgradient area. For the purposes of this study, the downgradient area was defined as extending from the Companies' groundwater treatment system (GWTS) north to the Las Vegas Wash (Figures 1-1 and 1-2). The laboratory analytical program consisted of the combined list of SRCs identified for the former Montrose and Stauffer facilities. This combined SRC list consisted of more than 340 compounds, which required 32 different analytical methods. These 32 analytical methods then included more than 550 compounds in total.

The second objective was to use the results of this downgradient sampling (combined with the recently NDEP-approved Quarterly Monitor Program and other site-related investigations currently being conducted at the onsite former facilities) as input to further develop the ongoing CSM discussed above. This CSM will encompass the onsite Pioneer property (including the former Montrose and Stauffer facilities) and downgradient areas to the Las Vegas Wash including facilities operated by Basic Remediation Company (BRC) and others.

The preliminary results of the Downgradient Study were presented to NDEP in September 2006, while a summary of some of the final validated results was presented on 21 February 2007 at the “all Companies” meeting in Henderson, NV.

ES.3 RESULTS AND DISCUSSION OF THE DOWNGRADIENT STUDY

ES.3.1 Conclusions

In general, very low to non-detectable concentrations for most of the SRCs were found in the Downgradient Study Area. Many of the organic compounds that were detected were along the southern and eastern portions of the study area from the southern boundary to about two-thirds of the way to the Las Vegas Wash, with most chemicals being non-detectable nearer to the Wash. These overall relatively low values are significant, as these chemicals are present at the former upgradient plant sites and upgradient of the GWTS (Hargis, 2007a, 2007b). Table 4-1 in the text of this report summarizes the prevalence of these key compounds.

Of particular note is the near absence of benzene, chlorobenzene, organic acids, DDT and DDT isomers among the 22 groundwater monitor wells sampled. Further observations for these and other compounds of particular interest at the site are as follows:

- Benzene and chlorobenzene were limited to one and three respective detections and were below established Federal Primary Maximum

Contaminant Levels (MCLs) for these compounds (5 and 100 ug/L, respectively).

- DDT and its isomer compounds (2,4-DDE, 2,4-DDD, 4,4-DDE, 4,4-DDD) were not detected among the 22 groundwater monitor wells sampled.

- The various di- and tri-chlorobenzene compounds were detected sporadically at low concentrations (below Federal Primary MCLs) throughout the downgradient area.

- 4-chlorobenzenesulfonic acid (p-CBSA), and benzenesulfonic acid were not detected among the 22 groundwater monitor wells sampled. The other three organic acids consisted of diethyl phosphorodithioic acid, dimethyl phosphorodithioic acid, and pthalic acid with 8, 6, and 16 detections at concentrations ranging from 0.05 to 8.5 mg/L.

- Both asbestos and white phosphorous were not detected in any of the Downgradient Study monitor wells.

Of the more than 340 SRCs, only four organic and three inorganic chemicals were found to exceed Federal Primary MCLs anywhere in the study area, with the organic compound exceedances limited to the southern and eastern portions of the study area extending to about two-thirds of the way between the southern downgradient area boundary at the GWTS and the Las Vegas Wash. Table 4-2 and several figures in the text of this report summarize these results. The chemicals for which these MCLs were exceeded were:

- Arsenic
- Fluoride
- Nitrate-N
- Gamma-BHC (Lindane)
- Carbon tetrachloride
- Chloroform
- Tetrachloroethene

The three inorganic parameters that exceeded their respective Federal Primary MCLs are summarized in more detail as follows:

- Arsenic was prevalent throughout the Downgradient Study Area at levels exceeding the MCL of 10 ug/L in 16 of the 22 monitor wells sampled. Concentrations of arsenic ranged from 9.4 to 270 ug/L.

- Fluoride concentrations were widely distributed throughout the downgradient area within a range of 1.8 to 11 mg/L. Four of the 22 monitor wells sampled had fluoride detections above the established MCL value of 4 mg/L with the higher detections concentrated in the southern portion of the Downgradient Study Area.

- Nitrate as Nitrogen (Nitrate-N) concentrations were evenly distributed throughout the downgradient area and were found within a range of 0.65 to 67 mg/L. Eight of the 22 monitor wells sampled had detections above the established MCL value of 10 mg/L for Nitrate-N with the highest detections concentrated in the southeastern portion of the downgradient area.

Of the organic compounds that exceeded MCLs:

- Gamma-BHC slightly exceeded its MCL of 0.2 ug/L in only one well (PC-040) at a concentration of 0.23 ug/L.

- Carbon tetrachloride was found in the DSA within a range of 0.67 to 11 ug/L and exceeded its MCL of 5 ug/L in three wells. These detections were limited to southern and eastern portion of the Downgradient Study Area.

- Tetrachloroethene (PCE) was found in the DSA within a range of 0.32 to 6.7 ug/L and exceeded its MCL of 5 ug/L in one well. Overall, PCE detections were distributed more evenly throughout the downgradient area, with the MCL exceedances limited to the southern portion of the Downgradient Study Area.

- Chloroform was found in the DSA within a range of 0.35 to 900 with one additional outlier of 1,400 ug/L and exceeded the MCL for all combined trihalomethanes of 80 ug/L in six wells, with the highest concentrations occurring in the southern and eastern portion of the study area, east of the main paleochannel. The elevated chloroform concentration were detected in only one well (PC-067).

Finally, while TDS does not have a Federal Primary MCL, it does have a Federal Secondary MCL value of 500 mg/L. TDS was detected at concentrations ranging from 1,800 to 16,000 mg/L in the Downgradient Study Area, with the highest values in the southern and eastern portion of the Downgradient Study Area closer to the GWTS and the lower values to the north toward the Las Vegas Wash. TDS values ranged from 2,300 to 2,800 mg/L in the two wells closest to the Wash.

ES.3.2 Recommendations

Because a limited number of MCL exceedences and some outlier concentrations were found by this study, absent any other monitoring program a reasonable recommendation would be to conduct some selected additional monitoring to confirm or refute the findings of this one time monitoring event. However, prior to the completion of this report, the Companies have worked with NDEP to establish and implement a quarterly monitoring program that covers an area from upgradient of the former Montrose and Stauffer plant sites through the Downgradient Study Area to the Las Vegas Wash (Hargis, 2006a). This quarterly monitoring program was approved by NDEP and currently consists of the following elements:

- 52 monitor wells for water level measurements;
- 38 monitor wells for water quality sampling; and
- Analyses include VOCs, SVOCs, Pesticides, Organic Acids, Metals, and various other organic and inorganic compounds.

Therefore, this program addresses the need for further selected monitoring in the Downgradient Study Area. As of the date of this study report, three quarters of sampling have been conducted to date (Hargis, 2007b and 2007c). As stipulated in the approved Quarterly Sampling Work Plan, the program is due to be evaluated after one year.

As stated earlier, the information developed by this Downgradient Study will be combined with information obtained from several other programs and synthesized into the ongoing CSM to assist in the discussion of chemical distribution in groundwater throughout the area to be addressed by the CSM.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

Page

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF APPENDICES

1.0 DOWNGRADIENT STUDY INTRODUCTION

1.1 Overview, Genesis and Timeline

This report for the Downgradient Study is being submitted on behalf of Montrose Chemical Corporation of California (Montrose), Pioneer Americas LLC (Pioneer), and Stauffer Management Company LLC/Syngenta Crop Protection, Inc. (Stauffer/Syngenta), herein referred to collectively as "the Companies." With the concurrence of the Nevada Department of Environmental Protection (NDEP), as referenced in its letter to the Companies dated 23 November 2005, the scope of work for the Downgradient Sampling Event was developed as part of the Companies' response to Action Item No. 7 of NDEP's letter, dated 16 February 2005, which states:

> *"Within 60 days, the Companies shall submit their approach and a schedule to NDEP to initiate accelerated work in accordance with Section IV(D)(2) of the Phase II Consent Agreement to investigate the nature and extent of contamination downgradient of the GWTS, mitigate offsite migration of contaminants and reduce risks to downgradient receptors."*

The Companies responded with two letters: one dated 1 May 2005 and a second one dated 13 October 2005. The former outlined a plan to compile existing groundwater data available in the downgradient area, while the latter presented an update on the progress of the downgradient study and recommended the preparation of a Work Plan for the downgradient work. NDEP concurred with this approach via a letter dated 23 November 2005, and the Companies subsequently submitted the Downgradient Work Plan to sample 22 existing monitor wells in the downgradient area on 12 January 2006 (Geosyntec, 2006a).

The Companies received approval to commence the Downgradient Study from NDEP on March 15, 2006, contingent upon finalizing the respective site-related chemicals (SRC) list for both former Montrose and Stauffer sites. NDEP approval for both of these lists (herein referred to as the "combined SRC list") was received by 17 July 2006.

This Downgradient Study consisted of a one-time sampling event of the 22 existing monitor wells in the downgradient area described in the *Work Plan for the Downgradient Groundwater Sampling Event* (Geosyntec, 2006a). The wells were first field-verified in March 2006, then sampled in mid to late July and early August 2006. The final data validation reports were received in late February 2007.

This report presents the results from that sampling event and briefly discusses the findings. A more detailed evaluation of these findings will be incorporated into the ongoing development of the combined site-wide Conceptual Site Model (CSM), which is due to NDEP in the fall of 2007.

1.2 Objectives

The first objective of the Downgradient Study was to collect one round of data for both groundwater-level elevations and groundwater quality in the downgradient area. For the purposes of this study, the downgradient area was defined as extending from the Companies' groundwater treatment system (GWTS) north to the Las Vegas Wash (Figures 1-1 and 1-2). The laboratory analytical program consisted of the combined lists of SRCs identified for the former Montrose and Stauffer facilities, which represent a subset of SRCs identified for all the Black Mountain Industrial (BMI) facilities. This combined list consisted of more than 340 compounds, which required 32 analytical methods.

The second objective was to use the results of this downgradient sampling (combined with the recently NDEP-approved Quarterly Monitor Program and other site-related investigations currently being conducted at the onsite former facilities) as input to further develop the CSM. This CSM will encompass the Pioneer property including the former Montrose and Stauffer facilities, and downgradient areas to the Las Vegas Wash including facilities operated by Basic Remediation Company (BRC) and others. It will also include data from the ongoing Quarterly Monitoring Program that the Companies are performing.

The preliminary results of this Downgradient Sampling Event were briefly presented to NDEP in September 2006, while a summary of selected final validated results were presented at the 21 February 2007 "All Companies" meeting in Henderson, Nevada.

1.3 Report Organization

Section 2 of this report discusses the project background, development of the SRCs, the history of groundwater activities in the downgradient area, data sources and database compilation activities; and the geology and hydrogeology of the downgradient area. Section 3 presents the Scope of Work and study methodology for the Downgradient Study.

Section 4 then discusses the resulting data evaluation for the downgradient area, keeping in mind that more thorough data evaluation and presentation will be incorporated into and provided with the combined CSM.

A summary and recommendations are presented in Section 5, while references are provided in Section 6. The Appendices present detailed backup, such as the field procedures, combined SRC list, laboratory analytical methods, certification issues, and data validation.

2.0 DOWNGRADIENT STUDY - PROJECT BACKGROUND

2.1 Development of Site-Related Chemicals

As a precursor to the Downgradient Study, extensive work was performed by the Companies to develop their respective SRC lists. Both the Stauffer and Montrose site SRC lists were developed with significant interaction with NDEP and their consultants. For details concerning the development of the SRC lists, the reader is referred to the following two reports:

- *Final Revised Evaluation of Site-Related Chemicals, Former Montrose Facility, Henderson, Nevada* (Earth Tech, 30 May 2006).

- *Evaluation of Site-Related Chemicals, Former Stauffer Chemical Company Facility, Henderson, NV* (PES, 1 June 2006).

The Stauffer and Montrose SRC lists developed by these two documents were combined to specify the analytical suite for use in the Downgradient Study. Appendix A presents the combined SRC list. Laboratory analytical methods, laboratory certification status, data validation, and other SRC-related issues are discussed further in Sections 3 and 4 of this current report and further detailed in the Appendices.

2.2 Development of Database for Groundwater Monitoring Data in the Downgradient Area

Many sources of groundwater-related data within the downgradient area were identified as part of this study. The primary sources included: AMPAC, BRC, the Desert Research Institute (DRI), the former Henderson Industrial Steering Committee (HISSC), Tronox (formerly Kerr McGee Chemical Corporation [KMCC]), NDEP, and Southern Nevada Water Authority (SNWA). Each of these entities in the past has performed or is currently performing work in the Downgradient Study Area. Geosyntec worked with each of them to obtain their reports, records, and databases, if available. This information then was compiled into a comprehensive database for the Downgradient Study Area.

This database then was used to examine available information on existing wells, such as well construction, lithologic information, history of water level measurements, water quality analyses, and sampling frequency, if available. Based on these analyses, 22 groundwater monitor wells then were selected for inclusion in the Downgradient Study. This process is further described in Section 3.

2.3 Geology and Hydrogeology in the Downgradient Area

2.3.1 Regional Geology

The Las Vegas Valley occupies a topographic and structural basin trending northwest-southeast and extending approximately 55 miles from near Indian Springs on the north to Railroad Pass on the south. The valley is bounded by the Las Vegas Range, Sheep Range and Desert Range to the north, the Frenchman and Sunrise Mountains to the east, the McCullough Range and River Mountains to the south and southeast, and the Spring Mountains to the west (ENSR, 2005a). The mountain ranges bounding the east, north, and west sides of the valley consist primarily of Paleozoic and Mesozoic sedimentary rocks (limestones, sandstones, siltstones, and fanglomerates), whereas the mountains on the south and southeast consist primarily of Tertiary volcanic rocks (basalts, rhyolites, andesites, and related rocks) that lie directly on Precambrian metamorphic and granitic rocks (Secor, 2000).

2.3.2 Hydrogeology

The hydrogeology of the downgradient area has been characterized by a number of parties conducting geologic investigations in the area. The following discussion is a brief summary of such findings.

Shallow Alluvial Aquifer: The downgradient area is located on Quaternary age alluvial deposits that slope north to the Las Vegas Wash. The alluvium consists of a reddish-brown heterogeneous mixture of well-graded sand and gravel with lesser amounts of silt, clay and caliche. Clasts within the alluvium are primarily composed of volcanic material. Boulders and cobbles are common. These alluvial materials comprise the unconfined alluvial aquifer. A major feature of the alluvial deposits is the stream-deposited sands and gravels that were laid down within paleochannels that were eroded into the surface of the Upper Muddy Creek Formation during infrequent flood runoff periods.

Previous site investigations, by way of geophysical survey information and corroboration of borehole log data, have yielded three main paleochannels trending to the Las Vegas Wash, with the primary paleochannel in the area trending from the BMI Complex to the northeast toward Las Vegas Wash. Figure 2-1 displays these paleochannel alignments based on the interpretations of BRC and Tronox presented in the following documents:

- *Conceptual Site Model, Kerr-McGee Facility, Henderson, NV* (ENSR, February 2005b).
- *Basic Remediation Company (BRC) Closure Report, Henderson, NV* (BRC, October 2004).

Upper Muddy Creek Formation: The fine-grained lucustrine facies of the Upper Muddy Creek Formation are dominated by silts and clays, but also include discontinuous sand layers and lenses. The limited water-bearing zones within this confined aquifer are thin sand layers and lenses contained within the overall fine-grained matrix of the facies. The piezometric head of this aquifer is typically 10 to 12 feet higher than the phreatic surface of the overlying unconfined aquifer (Kleinfelder, 2005).

3.0 DOWNGRADIENT GROUNDWATER INVESTIGATION ACTIVITIES

3.1 Sampling Locations

Based on the review of existing data, a total of 22 existing monitor wells were selected for sampling in the downgradient area. These monitor wells were confirmed to be completed in the alluvial water-bearing zone and nominally into the top of the Muddy Creek Formation. These sampling locations are shown on Figure 3-1, which also illustrates the main paleochannel trending northeast/southwest across the downgradient area and the ancillary eastern and western paleochannels interpreted by BRC and Tronox (BRC, 2006; ENSR, 2005b).

Table 3-1 summarizes these 22 monitor wells, their well construction, and lithologic data, all of which were used to select each well for sampling. The wells were selected based on their completion in the alluvial aquifer, known well construction information, whether the well has been sampled in recent years (indicating that the well still existed), proximity to interpreted paleochannel alignments, and proximity to the top of the Muddy Creek Formation. Table 3-2 presents a narrative summarizing the selection rationale for each well and is arranged in order by well from the southern end of the downgradient area, downgradient of the GWTS, to the northern part of the downgradient area, toward the Las Vegas wash.

Furthermore, the number and locations of the wells selected for the downgradient sampling event were selected to provide the adequate spatial distribution of data within the downgradient area. This coverage included rough transects along the southern upgradient portion of the offsite downgradient area (transect through wells H-56A, PC-040, PC-064, and PC-067), through the Pittman Lateral/Athens Road area (transect through wells TWE-15, PC-055 and ARP-6A), and toward the Las Vegas Wash (transect through MW-U, PC-077, PC-086, and PC-097). The remaining wells provided data to “fill in” the data distribution within the downgradient area.

A field reconnaissance was performed to determine access issues, whether the well still existed, actual well location, and suitability of the well for the sampling program. For example, well L645 could not be located in the field and was replaced with nearby well TWE-15. Several other wells were replaced with alternates, as they could not be located or were found submerged or damaged. A summary of the field reconnaissance effort was incorporated into the Groundwater Sampling Work Plan response to comments memorandum Henderson Downgradient Sampling Event Work: Well Reconnaissance Summary and Response to NDEP Comments (Geosyntec, 2006b) submitted to NDEP on March 28, 2006. These alternate wells are described in Table 3-2.

3.2 Field Sampling Plan

This section briefly describes the field sampling protocols, including water level measurements, groundwater sampling, quality assurance procedures, decontamination procedures, data management, and health and safety protocols. The detailed Standard Operating Procedures (SOPs) for these tasks are described in further detail in the Appendices.

Prior to the start of the sampling event, an onsite “kick-off” meeting was held with the laboratory, sampling contractor, and Geosyntec field personnel to review and discuss the following:

- The complexity of the program;
- The Site-specific Health and Safety Plan (HASP);
- The field sampling and laboratory testing program; and
- Assemblage of sampling equipment and sampling forms.

3.2.1 Low-Flow Sampling Procedures

Once the field equipment, sample bottles, and forms were assembled, the field sampling program began. As part of the low-flow purging and sampling activities at the monitor wells, the following tasks were completed:

1. Purging and sampling equipment was thoroughly cleaned and decontaminated to prevent cross-contamination between wells.

2. Water levels were measured by using an electric water level indicator, which was decontaminated between wells.

3. The monitor wells were purged by pumping at a low-flow sampling rate with a submersible Grundfos© Redi-Flo pump until stabilization of the various

water quality parameters occurred. The parameters were measured with a Horiba U-10 water parameter meter (or equivalent) and included pH, specific conductance, temperature, turbidity, and dissolved oxygen.

4. Water samples were collected in the designated containers by using the low-flow submersible Grundfos© Redi-Flo pump.

5. Samples were collected in appropriate containers supplied by the laboratory, then labeled and transferred to the laboratory under chain-of-custody protocol.

These tasks, including the low-flow purge and stabilization criteria, are described in detail in Appendices B and C. Field notes and low-flow monitor data sheets are provided in Appendix D.

3.2.2 Quality Assurance Procedures

Field QA samples were collected and analyzed to assess the consistency and performance of the groundwater sampling activities. QA samples for this sampling event included field duplicates, MS/MSD, equipment rinsates when necessary, and trip blanks.

A Quality Assurance Project Plan (QAPP) was prepared by Hargis + Associates on behalf of the Companies in accordance with the general requirements of the Nevada Division of Environmental Protection (NDEP). This QAPP was prepared for data obtained during soil and groundwater investigations to be conducted at the former Montrose and Stauffer sites in Henderson, Nevada. A copy of the QAPP is included in Appendix E.

3.2.3 Decontamination

The purpose of decontamination is: (1) to eliminate the transfer of contaminants from one groundwater monitor well to another; and (2) to protect the health and safety of personnel who may come in contact with contaminated equipment. Decontamination procedures described in Appendix C were performed at the beginning of each day of fieldwork, between each well, at the end of each day of fieldwork and whenever the equipment was suspected of having been contaminated.

A simple triple-rinse system was utilized to decontaminate the pump and electrical lead between wells. The triple-rinse system involves running the pump in cleaning tubes that contain three progressively cleaner grades of water. Appendix C documents the actual steps that were followed during these decontamination procedures.

3.2.4 Data Management

As specified in the work plan, data storage and documentation were maintained by using field data sheets and other technical forms throughout the sampling activities. Electronic data deliverables (EDDs) generated from the laboratory information management system (LIMS) were obtained from the laboratory contractor and housed in a single Microsoft Access database. This database is the basis for the generation of the analytical summary tables, statistical result tables, and maps used in this report.

3.2.5 Health and Safety

All field activities were performed by individuals with appropriate training (CFR1910.120), in accordance with the site-specific HASP. Before field activities commenced, the site-specific HASP was reviewed and signed by the sampling personnel. The HASP contains information pertaining to site conditions, potential hazards, hazard control, monitor procedures, personal protective equipment, emergency procedures, and hospital location. The HASP was available in the field for the sampling personnel in the event of a potentially hazardous situation. Field sampling personnel worked in modified Level D throughout the sampling event.

3.3 Laboratory Analytical Program – the combined SRCs and Certification Status

As stated earlier, extensive work has been performed by the Companies in developing their respective SRC lists. Appendix A of this report presents the combined SRC list.

Geosyntec submitted a memorandum Certification Status for the SRCs for the Downgradient Sampling Event, Henderson, Nevada (Geosyntec, 2006c) to NDEP on 13 July 2006, explaining the certification status of SRCs for the Downgradient Sampling Event. Ninety-two SRCs were identified in this memorandum as currently awaiting certification with NDEP's Bureau of Water Quality Planning (BWQP) branch. NDEP acknowledged receipt of the memo by way of email on 17 July 2006 and concurred with our intention to proceed with the sampling program with the existing certification status. All necessary certification documents have been provided by the project laboratory to the BWQP; however, Geosyntec is still awaiting certification for the vast majority of the 92 uncertified SRCs. Table 3-3 lists the compounds that still require certification by the BWQP, as of the date of this report.

It was agreed with NDEP that each groundwater sample would be analyzed for the combined list of Montrose and Stauffer SRCs for this Downgradient Study sampling event regardless of certification status.

4.0 FINDINGS

4.1 Groundwater Gradient and Direction

With regard to groundwater flow in the Downgradient Study Area, Figure 4-1 illustrates groundwater equipotential lines and gradient, including approximate flow direction. The overall groundwater gradient ranges from 0.008 to 0.017 toward the northeast and is consistent with historical site data. In addition, this general groundwater flow pattern toward the northeast is consistent with historical and ongoing quarterly monitoring data in the Downgradient Study Area (Hargis, 2007a, 2007b).

4.2 Chemical Character and Distribution

The groundwater samples that were collected for this Downgradient Study were analyzed for all Montrose and Stauffer SRCs (Appendix A); these compounds fall into the following parameter groups:

Volatile Organic Compounds (VOCs)	Aldehydes
Semi-Volatile Organic Compounds (SVOCs)	Asbestos
Total Petroleum Hydrocarbons (TPH)	Dioxins/Furans
Pesticides	Metals
Organic Acids	Inorganics (non-metal)

Various individual parameters were detected at varying frequencies within these groups. Table 4-1 provides prevalence information (number of analyses, number of detects, frequency of detects, minimum and maximum concentrations, etc.) on a parameter-by-parameter basis. Additionally, a data summary displaying groundwater analytical results by individual well and parameter is provided in Table 4-2. Analytical results qualified as a J-value, an estimated value where the reported concentration is below the reporting limit but higher than the method detection limit, are not included in the prevalence calculations. Similarly, analytical results qualified as rejected, as a result of the data validation review, were precluded from prevalence calculations. The following section provides a brief overview of the findings within these various parameter groups.

4.2.1 Volatile Organic Compounds (VOCs)

Groundwater samples were analyzed for the presence of VOCs by EPA Methods 504.1 and 8260B. Laboratory analysis indicates 50 of the 69 VOC SRCs were detected among the 22 groundwater monitor wells sampled. The concentrations of these VOCs were below established MCL levels, with the exception of three compounds: carbon tetrachloride, chloroform, and tetrachloroethene. Overall, these three organic compound MCL exceedances were limited to the eastern portion of the downgradient area, east of the main paleochannel, with the farthest northerly exceedance being chloroform at a concentration of 140 ug/L in monitor well PC-004, located approximately 4,200 feet upgradient of the Las Vegas Wash. VOC prevalence and summary results can be found in Tables 4-1 and 4-2. The following describes the occurrence and distribution of the MCL VOC exceedances for selected compounds of interest:

- Benzene and chlorobenzene concentrations in the downgradient area were scarce, with detections in only one and three of the 22 groundwater monitor wells sampled, respectively. The lone benzene concentration was 0.5 ug/L in well MW-K1, while chlorobenzene concentrations ranged from 0.43 to 89 ug/L. Benzene and chlorobenzene detections were spatially limited to the central-southern portion of the downgradient area at relatively low concentrations, with the exception of a chlorobenzene result of 89 ug/L found in monitor well MW-K1. However, the near absence of these two compounds in the downgradient area is significant, as they are two of the more prevalent compounds found in the upgradient former plant sites (Hargis, 2007a, 2007b). Benzene and chlorobenzene results are displayed on Figures 4-2 and 4-3.

- Chloroform was detected in 16 of the 22 groundwater monitor wells and ranged in concentration from 0.35 to 1,400 ug/L. Six wells located along the eastern portion of the downgradient area exhibited chloroform concentrations above the MCL value of 80 ug/L, with monitor well PC-004 being the farthest north. The highest chloroform concentration of 1,400 ug/L was found in the southeastern portion of the downgradient area in monitor well PC-067, an outlier relative to the concentration range (0.35 to 900 ug/L) found in the other wells. Chloroform results are displayed on Figure 4-4.

- Carbon tetrachloride was detected in four of the 22 groundwater monitor wells and limited to the eastern portion of the downgradient area, ranging in concentration from 0.67 to 12 ug/L, with three wells exceeding the MCL value of 5 ug/L. Monitor well ARP-6A, located in the central portion of the downgradient area and east of the main paleochannel, yielded the farthest northerly detection of carbon tetrachloride above the MCL at 5.4 ug/L. Carbon tetrachloride results are displayed on Figure 4-5.

- Tetrachloroethene (PCE) was detected in 13 of the 22 groundwater monitor wells, ranging in concentration from 0.32 to 6.7 ug/L, with one well exceeding the MCL value of 5 ug/L. Monitor well PC-040 exceeded the MCL with a concentration of 6.7 ug/L. PCE results are displayed on Figure 4-7.

Results for the remaining SRC related VOCs are displayed on Figures 4-8 through 4-24.

4.2.2 Semi-Volatile Organic Compounds (SVOCs)

Groundwater samples were analyzed for the presence of SVOCs by EPA Method 8270C. Laboratory analysis indicates 12 of the 49 SVOC SRCs were found detected among 12 of the 22 groundwater monitor wells sampled. Detected SVOCs were distributed primarily along the eastern portion of the downgradient area, east of the main paleochannel, at concentrations well below established MCL levels. SVOC prevalence and summary results can be found in Tables 4-1 and 4-2, along with pentachlorophenol and 1,4-dioxane results in Figures 4-25 and 4-26.

4.2.3 Total Petroleum Hydrocarbons (TPH)

Groundwater samples were analyzed for the presence of various hydrocarbons by EPA Methods 8015 modified and 8015B. Laboratory analysis indicates two of the three hyrdrocarbon SRCs (methanol and volatile fuel hydrocarbons C6-C12) were found detected among 14 of the 22 groundwater monitor wells sampled. These detected TPH-related SRCs were primarily distributed along the eastern portion of the downgradient area, east of the main paleochannel. Established MCL values do not exist for TPH. TPH prevalence and summary results can be found in Tables 4-1 and 4-2, and the results are displayed on Figures 4-27 (methanol) and 4-28 (volatile fuel hydrocarbons C6-C12).

4.2.4 Pesticides

Groundwater samples were analyzed for the presence of pesticides by EPA Methods 3510C/8081A and 8141A. Laboratory analysis indicates five of the 20 pesticide SRCs were detected among 16 of the 22 groundwater monitor wells sampled.

Very low concentrations of these pesticides were found distributed in the downgradient area, with the higher detections concentrated in the southern and central portion of the main paleochannel and the southeastern downgradient area. Pesticide prevalence and summary results can be found in Tables 4-1 and 4-2, with the results summarized for the various compounds on Figures 4-29 through 4-34.

Of the pesticides detected, only gamma-BHC was detected above MCLs. Gamma-BHC, detected in only three of the 22 groundwater monitor wells, was quantified in well PC-040 at a concentration of 0.23 ug/L, slightly above the MCL of 0.2 ug/L. Gamma-BHC results are displayed on Figure 4-32.

Finally, neither DDT nor any of its isomers (DDD and DDE) were detected in any of the Downgradient Study monitor wells (Figure 4-34).

4.2.5 Organic Acids

Groundwater samples were analyzed for the presence of organic acids utilizing the High-Pressure Liquid Chromatography (HPLC) method approved by NDEP. Laboratory analysis indicates two of the five organic acid SRCs (para-chlorobenzesulfonic acid (p-CBSA) and benzenesulfonic acid) were not detected in any of the downgradient monitor wells (Figures 4-35 and 4-36).

The other three organic acid SRCs (diethyl phosphorodithioic acid, dimethyl phosphorodithioic acid, and phthalic acid) were detected at concentrations ranging from 0.05 to 8.5 mg/L and were more prevalent in the southern downgradient area along the main paleochannel with just a few low-level detections occurring to the north near the Las Vegas Wash. The prevalence and summary results for these five organic acid compounds can be found in Tables 4-1 and 4-2 and the results displayed on Figures 4-35 through 4-39.

4.2.6 Aldehydes

Groundwater samples were analyzed for the presence of aldehydes by EPA Method 8315A. Laboratory analysis indicates that acetaldehyde was not detected, while chloroacetaldehyde and fomaldehyde were detected in four of the 22 groundwater monitor wells sampled at concentrations ranging from 3.9 to 44 ug/L. These isolated aldehyde detections were found to occur in the southeastern portion of the downgradient area, with the exception of a single and relatively low detection of chloroacetaldehyde in well PC-097 located near the Las Vegas Wash. Aldehyde compound prevalence and summary results can be found in Tables 4-1 and 4-2 and the results displayed on Figures 4-40 and 4-41.

4.2.7 Polychlorinated Biphenyls (PCBs)

With regard to PCBs, groundwater samples for the Downgradient Study were analyzed for the presence of PCBs by modified EPA Method 1668A. Laboratory analysis indicates 16 of the 28 PCB SRCs were detected among the 22 groundwater monitor wells sampled. PCB detects were found to be highest along the northern portion of the downgradient area near the Las Vegas Wash. However, detectable results were well below established MCL levels, while the aroclors were all non-detectable at the limit of quantification. PCB prevalence and summary results are presented in Tables 4-1 and 4-2 and displayed on Figures 4-43 through 4-58.

4.2.8 Dioxins and Furans

Groundwater samples were analyzed for the presence of dioxins and furans by modified EPA Method SW-846-8290. Laboratory analysis indicates SRC-related dioxin and furan compounds were detected at relatively low concentrations, as discussed below, in nine of the 22 groundwater monitor wells.

To put these detections in context, total equivalency (TEQ) calculations were performed on dioxin and furan detected compound results for comparison purposes against Federal Primary MCLs. TEQ values correspond to the concentration of 2,3,7,8-tetrachloro-*p*-dioxin with the same toxicity as the measured concentration of the respective dioxin/furan congener. Conversion of the congener concentrations to TEQ values allows comparison with the established Federal Primary MCL for 2,3,7,8-tetrachloro-*p*-dioxin of 30 picograms per liter (pg/L).

Calculated TEQs for all detected dioxin and furan compounds were found to be below the federally established MCL value of 30 pg/L and the TEQ values for these dioxins and furans are displayed on Figure 4-59.

4.2.9 Metals

Groundwater samples were analyzed for the presence of metals by EPA Methods 365.3, 6010B, 6020, 7199, and 7470A. Laboratory analysis indicates 26 of the 28 metal SRCs were found detected among the 22 groundwater monitor wells sampled. All of these detections were below established MCL levels, with the exception of arsenic as discussed below:

- Arsenic was detected in the 22 groundwater monitor wells sampled and ranged in concentration from 9.4 to 270 ug/L. These concentrations were found above the MCL value of 10 ug/L in 16 of the 22 monitor wells sampled, with a fairly even distribution throughout the downgradient area. Monitor well PC-028 yielded the highest concentration for arsenic. Arsenic results are displayed on Figure 4-60.

Metal prevalence and summary results are summarized in Tables 4-1 and 4-2, while the results of arsenic and chromium and other selected metals; chromium VI, manganese, molybdenum, phosphorous, white phosphorus, and vanadium are displayed on Figures 4-60 through 4-67.

4.2.10 Inorganics (non-metal)

Groundwater samples were analyzed for the presence of inorganic compounds by a variety of EPA-established methodologies (Appendix A). Laboratory analysis indicates 14 of the 16 inorganic (non-metal) SRCs were detected among the 22 groundwater monitor wells sampled. The prevalence and summary results of these inorganic compounds are summarized in Tables 4-1 and 4-2. Fluoride and nitrate were the only inorganic compounds found above established MCL levels asdescribed below:

- Fluoride concentrations were widely distributed throughout the downgradient area, with the more elevated detections concentrated in the southern portion of the downgradient area. Four of the 22 monitor wells sampled had detections above the established MCL value of 4 mg/L, with concentrations ranging from 1.8 to 11 mg/L. Monitor well H-56A, located in the southwestern portion of the downgradient area, yielded the highest Fluoride concentration of 11 mg/L. Fluoride results are displayed on Figure 4-68.

- Nitrate-N concentrations were evenly distributed throughout the downgradient area, with higher detections concentrated in the southeastern portion. Eight of the 22 monitor wells sampled had detections above the established MCL value of 10 mg/L, with concentrations ranging from 0.65 to 67 mg/L. Nitrate-N results are displayed on Figure 4-69.

Finally, total dissolved solids (TDS) were measured in groundwater samples by EPA Method 160.1 in all 22 monitor wells. TDS concentrations ranged from 1,800 to 16,000 mg/L in the 22 downgradient wells, with the lowest and highest concentrations in wells PC-004 and PC-067, respectively. The two wells closest to the Wash (PC-086 and PC-097) yielded TDS values of 2,300 and 2,800 mg/L, respectively. TDS results are displayed on Figure 4-70.

4.2.11 Asbestos

Groundwater samples were analyzed for the presence of asbestos by EPA Method 100.1. Laboratory analysis indicates that asbestos was not found in any of the 22 groundwater monitor wells sampled.

4.3 Quality Assurance Results

Field quality assurance (QA) samples were collected and analyzed to assess the consistency and performance of the groundwater sampling activities. QA samples for this sampling event included field duplicates, matrix spike/matrix spike duplicates (MS/MSDs), equipment rinsate blanks, and trip blanks. Table 4-3 summarizes the findings for these samples, along with the laboratory explanation as to the probable cause of the detected compound. The following sections describe the relevance and findings of these QA samples in greater detail.

4.3.1 Trip Blanks

Trip blanks were evaluated to determine whether VOC cross-contamination between samples has occurred during storage and transportation. Trip blanks were prepared by the laboratory in 40-milliliter (mL) vials with analyte-free water and must be free of headspace. Trip blanks were carried into the field, stored, and shipped to the laboratory along with the water samples. One trip blank was shipped with each cooler containing samples to be analyzed for VOCs only by EPA Method 8260.

A total of 12 blanks were collected throughout the sampling event. Laboratory-analyzed trip blanks were free of detections, with the exception of a single trip blank. This one trip blank (TB-0801) had an estimated methlyene chloride detection of 0.81 ug/L qualified as a J-value, an estimated value where the reported concentration is below the reporting limit but higher than the method detection limit. It should be noted that methlyene chloride is a common laboratory contaminant.

4.3.2 Field Blanks

Collection and analysis of field blanks are provided as QA checks on the integrity of sample collection and handling procedures. Field blank samples were prepared by using deionized water and the sample bottles randomly selected from the bottles prepared for the environmental samples. A single field blank was collected on each day that the environmental samples were collected and analyzed by EPA Method 8260.

Eleven field blanks were collected throughout the sampling event. Four of the 11 field blanks collected had estimated concentrations (J-values) of VOCs.

4.3.3 Equipment Blanks

Collection and analysis of field equipment blanks are provided as QA checks on the integrity of equipment decontamination procedures. Equipment rinsate samples were prepared by using deionized water and sample bottles randomly selected from the bottles prepared for environmental samples.

One equipment rinsate blank was collected and analyzed for VOCs only by EPA Method 8260B for each day of sampling when using non-dedicated equipment to sample groundwater. Additionally, three equipment rinsate blanks were collected and analyzed throughout the course of the sampling program (near the beginning, middle, and end of the sampling program from non-dedicated sampling equipment) and analyzed for SVOCs by EPA Method 8270C, Organochlorine and Organophosphorous Pesticides by EPA Method 8081A, Organic Acids by HPLC, and Total Petroleum Hydrocarbons by EPA Method 8015M.

Eleven equipment blanks were collected throughout the sampling event. Seven of the 11 equipment blanks reported estimated (J-value) concentrations of various VOCs, SVOCs, TPH, and TIC compounds. As previously mentioned, estimated concentrations differ from non-qualified detections in that while the concentrations exceed the method detection limit, they fall below the method reporting limit. Typically, only values exceeding the reporting limits are considered true and viable detections.

4.3.4 Field Duplicates

Field duplicate samples are used to evaluate the precision of the overall sample collection and analysis process. Field duplicates are two samples (an original and a duplicate) of the same matrix collected at the same time and location and using the same sampling techniques, to the extent practicable. Field duplicates were collected at a frequency of one per 10 regular samples and analyzed for the full set of analyses used for the regular sample collected.

Field duplicate samples were collected in groundwater monitor wells MW-AJ and ARP-6A. Results of these duplicate samples were found comparable to the results for the original sample.

4.4 Data Validation

Geosyntec obtained Level 4 Data Validation Packages (DVPs) for all of the groundwater samples and had Level 3 (80% of sample population) and Level 4 (20% of sample population) data validation summaries prepared for the samples. Laboratory Data Consultants (LDC) of Carlsbad, CA performed data validation. A memorandum was submitted by Geosyntec to the NDEP on 11 July 2006 describing the data validation approach for the Downgradient Study Sampling Event in detail and is provided as Appendix F.

Of the 11,915 total analytes reported for this downgradient sampling event, eight of the sample results were rejected, resulting in a 99.9% completeness rating (Table 4-4). Table 4-5 displays the rejected data along with the data validation explanation.

A data validation summary report (DVSR) was prepared by the data validators for this project and is included as Appendix G.

5.0 SUMMARY AND DISCUSSION

5.1 Summary

5.1.1 General Observations

In general, very low to non-detectable concentrations of most SRCs were found in the Downgradient Study Area. Detections of organic compounds were limited primarily to an area along the southern and eastern portions of the study area, ranging from the southern boundary to about two-thirds of the way to the Las Vegas Wash. At the Wash, most organic chemicals were non-detectable.

Of particular note is the near absence of benzene and chlorobenzene and the complete absence of pCBSA, benzenesulfonic acid, DDT and its associated compounds DDD and DDE among the 22 groundwater monitor wells sampled in the downgradient area. Detections of benzene and chlorobenzene were limited to one and three detections respectively while no detections were observed for pCBSA, benzenesulfonic acid, and DDT compounds.

5.1.2 Organic Compound MCL Exceedances

Of the more than 340 SRCs targeted for this investigation, only four organic and three inorganic chemicals exceeded Federal Primary MCLs. Table 4-6 summarizes the compounds and the wells in which those compounds exceeded the Federal Primary MCLs during the Downgradient Study sampling event. The organic compounds for which the MCLs were exceeded were:

- Gamma-BHC (Lindane)
- Carbon tetrachloride
- Chloroform
- Tetrachloroethene

The organic compound exceedances were limited to the southern and eastern portions of the study area extending to about two-thirds the distance north from the southern downgradient area boundary and the Las Vegas Wash. Chloroform and carbon tetrachloride MCL exceedances were limited to the eastern portion of the downgradient area, east of the main paleochannel. The one PCE and one gamma-BHC MCL exceedances were located in the southern downgradient area.

5.1.3 Inorganic Compound MCL Exceedances

Three inorganic compounds were found to exceed Federal Primary MCLs during the Downgradient Study sampling event. The inorganic compounds for which the MCLs were exceeded were:

- Arsenic
- Fluoride
- Nitrate-N

As stated earlier, arsenic was prevalent throughout the Downgradient Study Area at levels exceeding the MCL of 10 ug/L. Fluoride and nitrate concentrations were widely distributed throughout the downgradient area exceeding MCLs in four and eight monitor wells respectively. Finally, even though TDS does not have a primary MCL, it was detected in concentrations ranging from 1,800 to 16,000 mg/L, with the higher values in the southern portion of the study area closer to the GWTS and the lower values to the north toward the Las Vegas Wash. TDS has a secondary MCL value of 500 mg/L.

5.2 Discussion

Because a limited number of MCL exceedences and unusual outlier concentrations were found by this study, absent any other monitoring program a reasonable recommendation would be to conduct additional selected monitoring to confirm or refute the findings of this one time monitoring event. However, prior to the completion of this report, the Companies have worked with NDEP to establish and implement a quarterly monitoring program that covers an area from upgradient of the former Montrose and Stauffer plant sites through the Downgradient Study Area to the Las Vegas Wash (Hargis, 2006a). This Quarterly Monitor Program was approved by NDEP and currently consists of:

- 52 monitor wells for water level measurements;

- 38 monitor wells for water quality sampling; and

- Analyses include VOCs, SVOCs, Pesticides, Organic Acids, Metals, and various other organic and inorganic analytical methods.

Three quarters of sampling have been conducted to date. The Fourth Quarter 2006 sampling round was completed in November 2006 and was recently reported in the Quarterly Monitor Report, Fourth Quarter 2006, Hargis + Associates, 15 February 2007 (Hargis, 2007a). The sampling round for the First Quarter 2007 recently was completed in February 2007, with the report issued in April 2007 (Hargis, 2007b). This Quarterly Sampling Program is due to be evaluated after one year.

Additionally, based on the results of this Downgradient Study Sampling Event reported herein, unusual chemical concentrations relative to other nearby wells of certain chemicals were noted in two wells. Chlorobenzene at well MW-K1 and chloroform at well PC-067, were unusually elevated. This apparent disparity relative to the general pattern of concentration of those chemicals in the vicinity of these wells bears additional attention to confirm the observed concentrations. These two wells are currently gauged for water elevations for the Quarterly Sampling Program. To provide further confirmation of the analyses conducted for the downgradient sampling event, monitor well PC-067 was sampled during the the second quarter 2007 sampling event in April 2007 to validate the apparent chloroform anomaly. Additionally, monitor well MW-K1 will be sampled for the upcoming third quarter 2007 sampling event to validate the chlorobenzene concentration.

Finally, the Companies currently are compiling all available information into the ongoing CSM. This information includes the data from the Downgradient Study, the ongoing Quarterly Monitor, evaluation of the GWTS, and the BRC CAMU area, as well as the ongoing extensive studies being conducted at the former Montrose and Stauffer sites.

6.0 REFERENCES

Basic Remediation Company (BRC), 2004. Site Closure Report, Henderson, Nevada.

Earth Tech Inc. (Earth Tech), 2006. Final Revised, Evaluation of Site-Related Chemicals, Montrose Site, Henderson, Nevada. May 30.

ENSR International, 2005a. Upgradient Investigation Workplan, Kerr-McGee Chemical LLC, Henderson, Nevada.

ENSR International, 2005b. Conceptual Site Model, Kerr-McGee Facility, Henderson, Nevada. February 2005.

Geosyntec Consultants (Geosyntec), 2006a. Work Plan for the Downgradient Groundwater Sampling Event, Henderson, Nevada, January 12.

Geosyntec Consultants, 2006b. Henderson Downgradient Sampling Event Work: Well Reconnaissance Summary and response to NDEP Comments, Henderson, Nevada. March 28.

Geosyntec Consultants, 2006c. Certification Status for the Site-Related Chemicals (SRCs) for the Downgradient Sampling Event, Henderson, Nevada. July 13.

Hargis + Associates (Hargis), 2006a. Work Plan for Quarterly Groundwater Sampling, Henderson, Nevada, January 12.

Hargis + Associates, 2006b. Quarterly Groundwater Monitor Report, Fourth Quarter 2006, Henderson, Nevada, November 2006.

Hargis + Associates, 2006c. Quarterly Groundwater Monitor Report, First Quarter 2007, Henderson, Nevada, April 2007.

Kleinfelder, 2005. Hydrogeologic Investigation – 2005, Phase V Drilling, American Pacific Corporation, Henderson, Nevada. July 27.

PES Environmental, Inc. (PES), 2006. Evaluation of Site-Related Chemicals Former Stauffer Chemical Company Facility, Henderson, Nevada. June 1.

Secor, 2000. Additional Groundwater Investigation Report, Closed Montrose Ponds, Former Montrose Facility, Henderson, Nevada. February 2.